Chapter 3
Generators and Motor-Generators

3-1. General

Design of generators and motor-generators is specified as a contractor responsibility. Design requirements and specifications are the responsibilities of electrical discipline within the Corps of Engineers (see EM 1110-2-3006 for guidance). Guide Specification CW-16210 provides the basis for preparation of contract specifications. Mechanical design includes the following responsibilities: coordination of turbine and generator mechanical characteristics; required generator handling facilities; and oil, air, carbon dioxide (CO_2), and water service connections to the generator. Design considerations for the generator as related to the turbines, cranes, and piping systems are covered under the respective chapters of this manual. Discussion in this chapter pertains to mechanical considerations in completing generator guide specifications.

3-2. Turbine Considerations

Powerhouse scheduling normally requires contracting of the turbines prior to preparation of generator specifications. This permits the required turbine data for the generator specification to be obtained from the turbine specification, the turbine bid data, and the turbine model test. Preadvertising correspondence with turbine and generator suppliers should provide verification that the turbine related stipulations in the generator specification are practicable. The required flywheel effect of rotating generator parts must be computed on the basis of all related factors. This includes turbine characteristics as well as penstock, generator, governor, and power system characteristics. Maximum speed rise and pressure rise upon loss of generator load are normally the critical mechanical factors. Turbines and generators are specified to withstand stresses due to runaway speeds; however, the damaging effects of vibrations are indeterminate and require conservative limits on speed rise. Maximum speed rise should normally be limited to 40 percent above synchronous speed when the required WR^2 can be obtained with a normal generator design. When the 40 percent limitation would require a special generator rotor rim design or separate flywheel, a greater allowable speed rise may be warranted but should not exceed 60 percent in any case. Maximum pressure rise at the turbine is usually limited to 30 percent above the maximum static pressure.

3-3. Handling Provisions

The powerhouse crane is normally sized to handle the generator parts, and no size or weight restrictions should be included in the generator specification. Certain powerhouses may justify two (2) cranes coupled together for handling the heavier parts. These should also be designed to meet the generator requirements. Exceptions to this policy may be required where a new unit is being provided in an existing crane equipped powerhouse, or where scheduling revisions require a crane to be under contract before a generator contract is awarded. In either case, the appropriate crane limitation should be included in the generator specification. Ratings for a crane procured before generator data are available should be based on prebid exchange of information with generator suppliers. Crane design guidance is covered in Chapter 6 of this manual. For existing powerhouses, a crane clearance diagram, powerhouse access limitations, and other applicable physical limitations should be included in the generator specifications.

3-4. Service Systems

a. Oil. The powerhouse lube oil system supply and return lines which serve the generator bearing system are normally terminated within the generator housing near the top or bottom of the turbine pit. It is generally not practicable to determine exact locations at the preparation time of generator specifications, so it is satisfactory to negotiate final connecting points for generator and powerhouse piping during shop drawing review. Filtering and purifying of lube oil at the unit is normally not required except at the initial filling. This should be accomplished with government furnished filters and powerhouse portable purifiers. Oil coolers with water coils are normally supplied from the same cooling water system as the air coolers and turbine bearing coolers. Paragraphs 2-2*g* and 10-2 provide guidance concerning maximum differential pressure, design pressure, test pressure, cooling water temperature, and cooling water supply.

b. Air. Compressed air for operation of the generator brakes is supplied from the powerhouse brake air system as discussed in paragraph 13-3. Generator specifications should normally include values of 689 kPa (100 psi) as the nominal system pressure and 517 kPa (75 psi) as minimum system pressure. Piping terminations are generally as noted above in paragraph 3-4*a* for oil piping.

c. Carbon dioxide systems. The CO_2 piping terminations are generally as noted above in paragraph 3-4*a* for oil piping. In powerhouses where the CO_2 powerhouse headers are routed above the generator floor elevation, it may be preferable to route the connecting lines overhead to enter the generator housing near the top. Paragraph 15-4 provides guidance on generator CO_2 systems.

d. Water. Powerhouse cooling water supply and discharge lines serving the generator air coolers and bearing oil coolers are normally terminated in the lower generator housing. Cooling water head and temperature considerations and test pressures should be as discussed in paragraph 2-2*g* for turbine bearing coolers. Related comments on generator cooling water supplies are included under paragraph 10-2. Temperature modulation of the generator cooling water should be provided for units where it is necessary to modulate the cooling water flow to assure a cooling water discharge temperature which meets powerhouse heating requirements. The generator specification should include a statement on the type of control that will be provided in the powerhouse cooling water piping and the modulated temperature. When modulation is proposed for other reasons, a statement to this effect should also be included in the generator specification. In all cases where the cooling water flow is modulated, a low-flow bypass should be provided around the modulating valve to allow minimum flow for startup.